# FORESTRY

**Project title: Remote Sensing-Based Geostatistical Modeling for Coniferous Forest Inventory and Characterization**

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Objective: In May 1999, KU's Kansas Applied Remote Sensing (KARS) Program was chosen by NASA to develop methods that use remote-sensing data and advanced geostatistical methods to create maps of forest age and successional state, or cover types, and of forest biophysical factors, including density, biomass, leaf area, basal area, and height. Geostatistical methods take advantage of the spatial dependence in forest variables and remotely sensed data. By calibrating remotely sensed multispectral data with a small number of ground measurements, characteristics of the forest measured at sample points can be extrapolated across a large geographic region. This has significant advantages for forest management, especially when forests are in remote or inaccessible locations. Benefits of the integrated remote sensing/geostatistics approach will include a reduction in the amount of time and costs required for forest inventory and mapping. The maps produced using the technique will provide information on forest characteristics that previously were very difficult or impossible to map, including the leaf area index (LAI) and aboveground biomass. By monitoring changes in forest characteristics over time, forest managers can use the geostatistical remote sensing technique to map insect defoliation, wildfire damage, and regeneration of the forest. The project will develop two demonstration projects, showing the use of remote sensing and geostatistical analysis for insect damage assessment and mapping forest cover types. A web site has been developed (www.kars.ukans.edu/forest).

Findings: 2001 Yellowstone Field Campaign: In cooperation with the Kansas NASA EPSCoR Office and the KU School of Aeronautical Engineering, the Kansas project carried out an overflight of selected study areas in Yellowstone using the new KARS Airborne Duncan Digital Multispectral Camera. The overflights were scheduled to be coincident with both ground sampling of spectral reflectance and with satellite image acquisitions by the Landsat 7 ETM and the EO-1/Hyperion sensors on July 18. Heavy cloud cover on the day of overpass—a rarity for that time of year in Yellowstone—yielded poor satellite and airborne imagery and poor field data. Airborne imagery acquired by the KU system several days later (July 19–21) were of very high quality (0.4 meter spatial resolution, three spectral bands). Over 2,000 multispectral digital images of the park were acquired during the series of overflights (samples available on request). Currently, this data is being processed for use in the KARS research, and will be made available to other Yellowstone researchers at a later date. The field sampling campaign for the Central Plateau of Yellowstone was planned and carried out in July 2001. Data on forest density, height, basal area was collected from sample plots in an area west of the West Thumb area, south of the Craig Pass Road. Data were collected at five field sampling grid resolutions (100 m, 250 m, 355 m, 500 m and 1,000 m). Over 200 new field sampled points were collected on the nested grids during the July field season.

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The second order image texture improves overall classification of forest age classes by over 30%, similar to results shown by other researchers. The most significant improvement is for the uneven age, uneven canopy, Engelmann spruce and subalpine fir stands (LP3), which have proven to be a difficult age class to map. This could be due to structural components of the stand (shadows) which are summarized in the pixel information level. However, with the higher resolution of the Landsat TM 7 panchromatic band, this structural component can be captured with the application of second order image texture. We have demonstrated that mapping forest stand age stages of the Central Plateau of Yellowstone National Park can be achieved when Landsat TM 7 imagery spectral and spatial components are employed.

The study also assessed how well airborne hyperspectral AVIRIS image data could discriminate differences between seedling densities in postfire regenerating sites, as compared to Landsat TM satellite data. In most forestry applications seedlings or postfire regenerating areas are usually grouped into one class. Our results show that a more detailed discrimination of the seedling class is possible, especially when hyperspectral data are available. The statistical analysis performed in this project showed the application of AVIRIS hyperspectral imagery to be an improvement in the discrimination of the seven seedlings density classes by almost 20% as compared to the Landsat TM imagery. A website has been developed for other Yellowstone researchers to download Landsat satellite imagery from our server (http://www.kars.ukans.edu/forest/landsat7.html). The data is free of all restrictions, and other data sets are available on request.

**Project title: White Pine Blister Rust in the Greater Yellowstone Area: Local Spread and Intensification of an Introduced Pathogen**

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Objective: White pine blister rust is recognized as the most damaging North American conifer disease. The disease is caused by a fungus that alternates between white pines and gooseberry and currant shrubs (*Ribes* species). Impacts from the disease have been documented in relatively pristine forests such as those of the Greater Yellowstone Area (GYA). Whitebark pine *(Pinus albicaulis)* and limber pine *(Pinus flexilis)* are the only white pines that occur within the GYA, with whitebark pine inhabiting more acreage than limber pine. White pine blister rust may be the most severe threat that these valuable trees are facing. The overall goal of this study is to increase our understanding of the disease system and its expected impacts.

Throughout the GYA there are some sites showing high disease intensities while some sites remain at low infection levels. The study objective is to characterize sites with and without disease intensification to learn what factors may be associated with high infection levels. Specifically, the following questions are being studied: 1) Are there site characteristics related to host plant (Ribes and white pine) densities and distributions that correlate with whitebark pine infection levels? 2) Does the seasonal timing of Ribes leaf development influence Ribes infection levels, and what methodology is best for measuring Ribes infection levels? 3) What environmental conditions occur within the canopies of Ribes and pine hosts in whitebark pine forests?

Findings: During the summer of 2001 a total of 18 whitebark pine stands with variable infection levels were visited and quantitatively characterized. Two sites were located within Yellowstone National Park, one on Mount Washburn and one on Avalanche Peak. Both of these sites showed low whitebark pine infection levels. Additionally, weather-monitoring data-logger equipment was positioned at two sites. One weather monitoring station was located in the Gallatin National Forest on Palmer Mountain and the other within Grand Teton National Park on Rendezvous Mountain. Qualitative data was also collected on Ribes distributions, relative infection levels, and leaf phenology. The study is ongoing and additional field data will be collected during 2002.

**Project title: Geologic Controls on Ecology of the Greater Yellowstone Ecosystem, Particularly the Grassland-Forest Contrast**

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Objective: The soil moisture sensors were installed at both transect sites and recording begun at 12-hour intervals.

Findings: Post-installation checks indicated that the data loggers were recording as programmed.